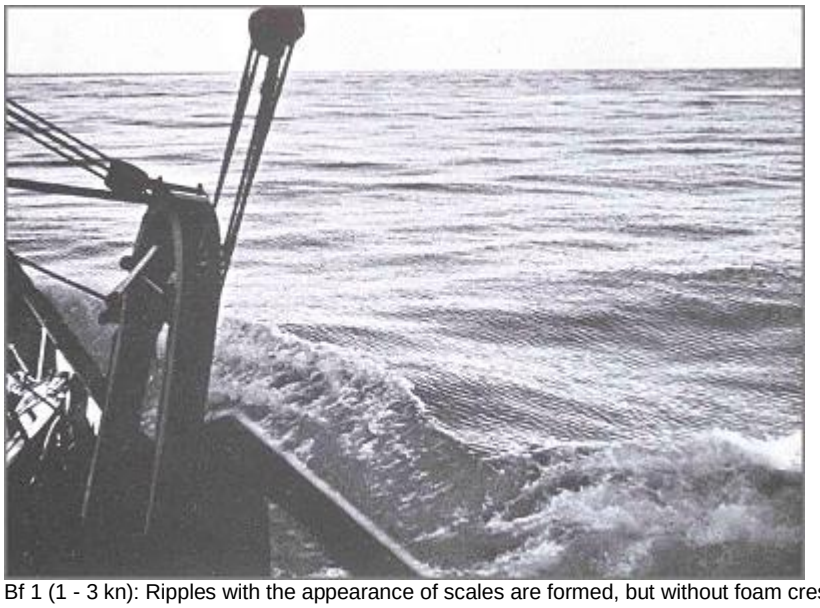
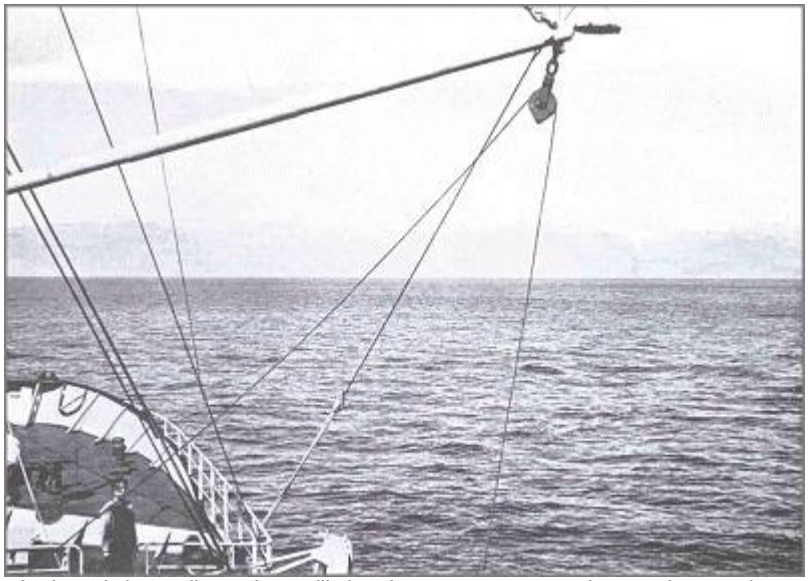
Beaufort scale Deutscher Weterdienst

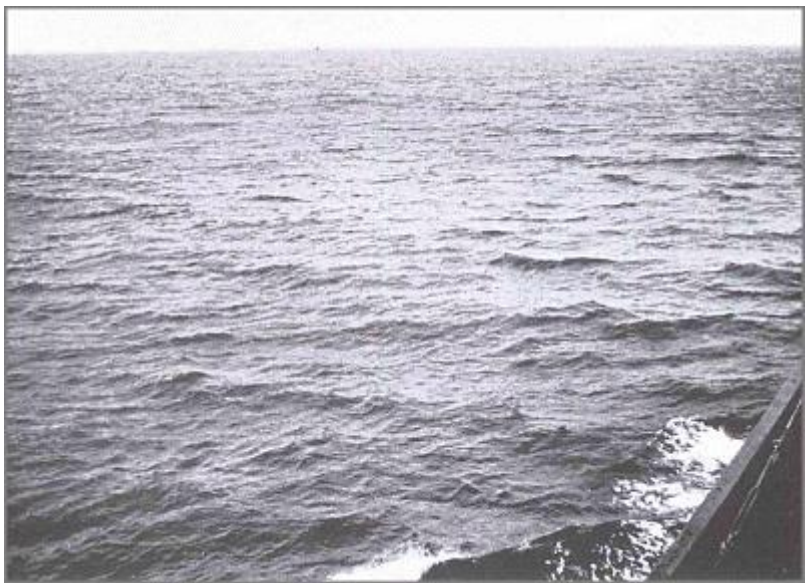
Bf 0 (< 1 kn): Sea like a mirror



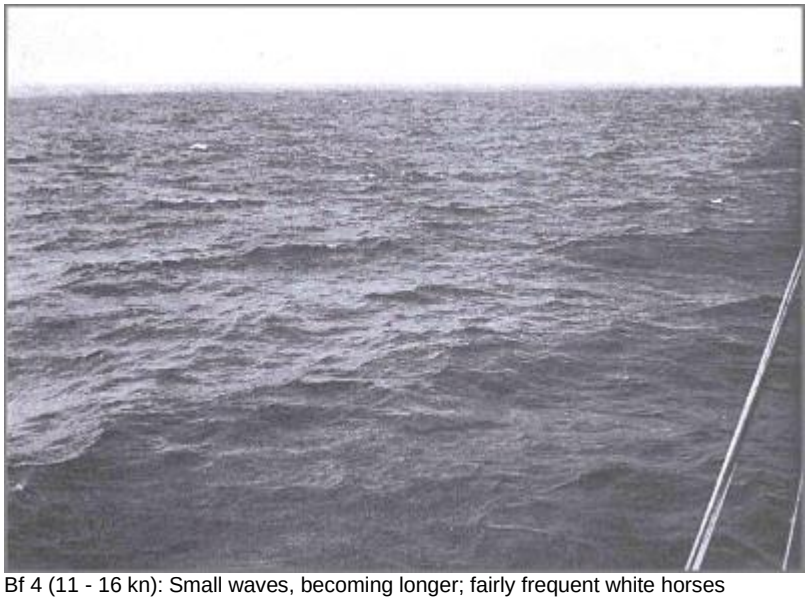
Bf 1 (1 - 3 kn): Ripples with the appearance of scales are formed, but without foam crests



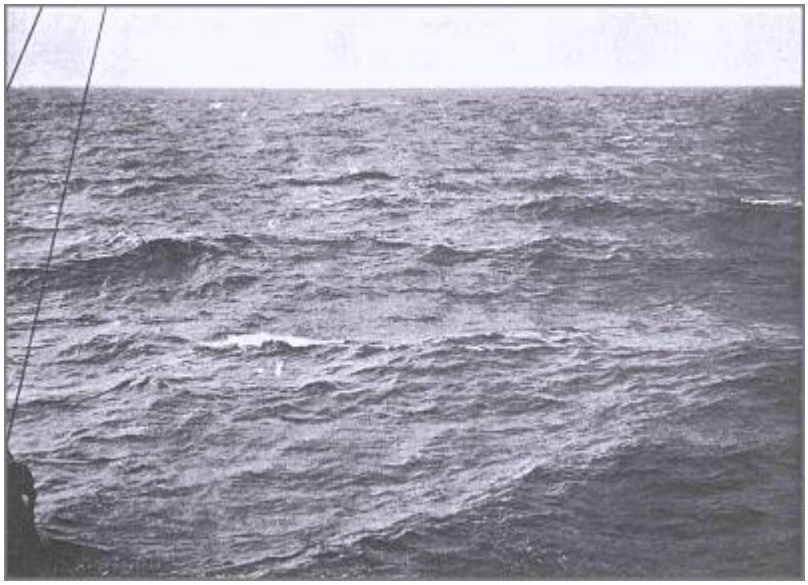
Bf 2 (4 - 6 kn): Small wavelets, still short but more pronounced: crests have a glassy appearance and do not break (Remark: On this particular photo: besides of the wind sea, the remainders of a low swell are shown)



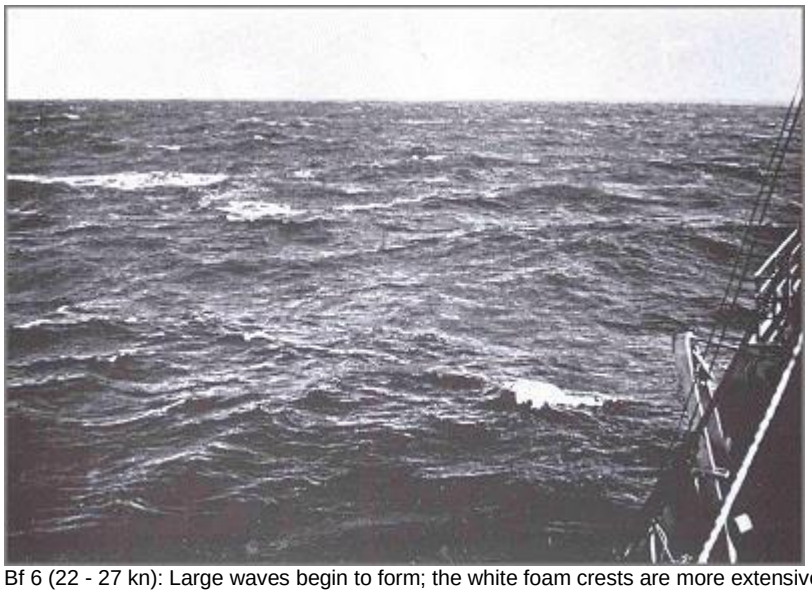
Bf 3 (7 - 10 kn): Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses



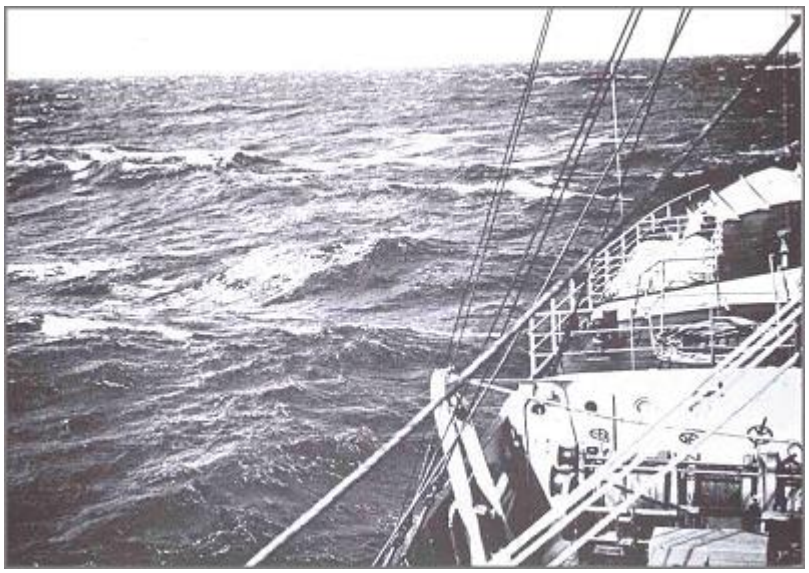
Bf 4 (11 - 16 kn): Small waves, becoming longer; fairly frequent white horses



Bf 5 (17 - 21 kn): Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray)



Bf 6 (22 - 27 kn): Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray)

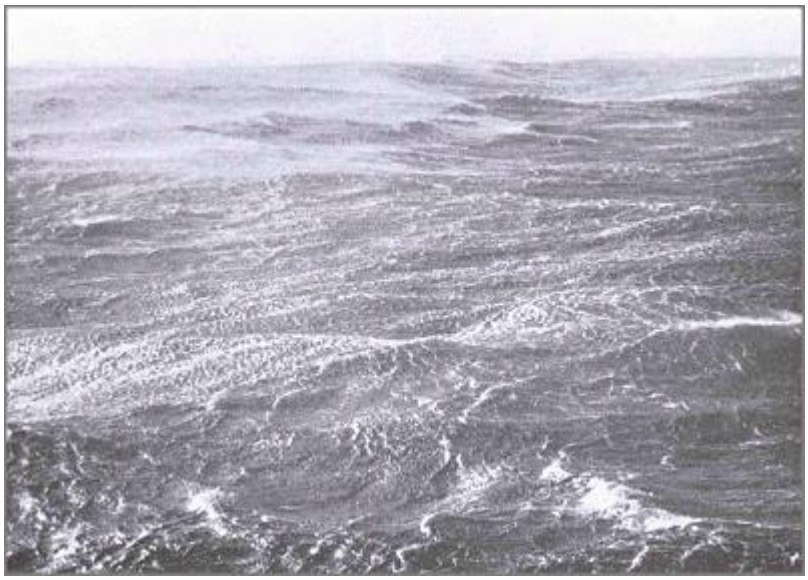


Bf 7 (28 - 33 kn): Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind

Bf 8 (34 - 40 kn): Moderately high waves of greater length; edges of crests begin to break into the spindrift; the foam is blown in well-marked streaks along the direction of the wind

Bf 9 (41 - 47 kn): High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility

Bf 10 (48 - 55 kn): Very high waves with long overhanging crests; the resulting foam, in greater patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; the tumbling of the sea becomes heavy and shock-like; visibility affected



Bf 11 (56 - 63 kn): Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected

Bf 12 (> 63 kn): The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected

All photos Deutscher Wetterdienst

Beaufort scale Environment Canada

Bf 0 (< 1 kn): Sea like a mirror

Bf 1 (1 - 3 kn): Ripples with the appearance of scales are formed, but without foam crests

Bf 2 (4 - 6 kn): Small wavelets, still short but more pronounced: crests have a glassy appearance and do not break

Bf 3 (7 - 10 kn): Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses

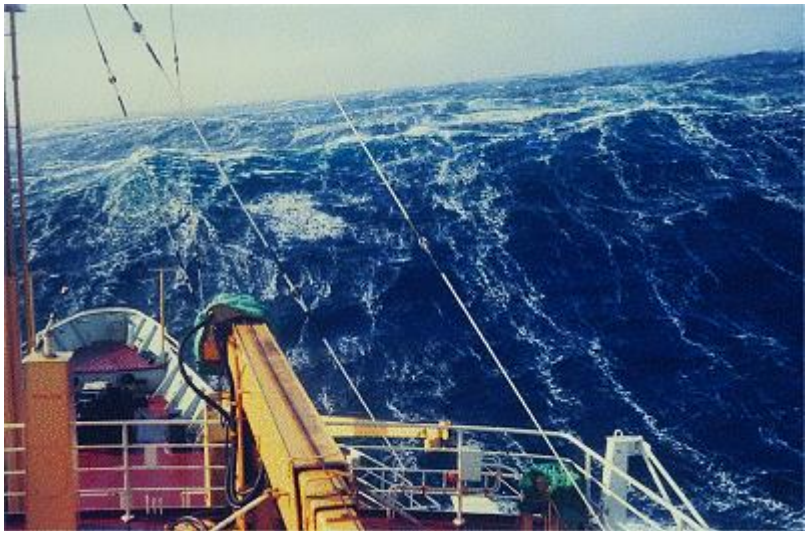
Bf 4 (11 - 16 kn): Small waves, becoming longer; fairly frequent white horses

Bf 5 (17 - 21 kn): Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray)

Bf 6 (22 - 27 kn): Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray)

Bf 7 (28 - 33 kn): Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind

Bf 8 (34 - 40 kn): Moderately high waves of greater length; edges of crests begin to break into the spindrift; the foam is blown in well-marked streaks along the direction of the wind



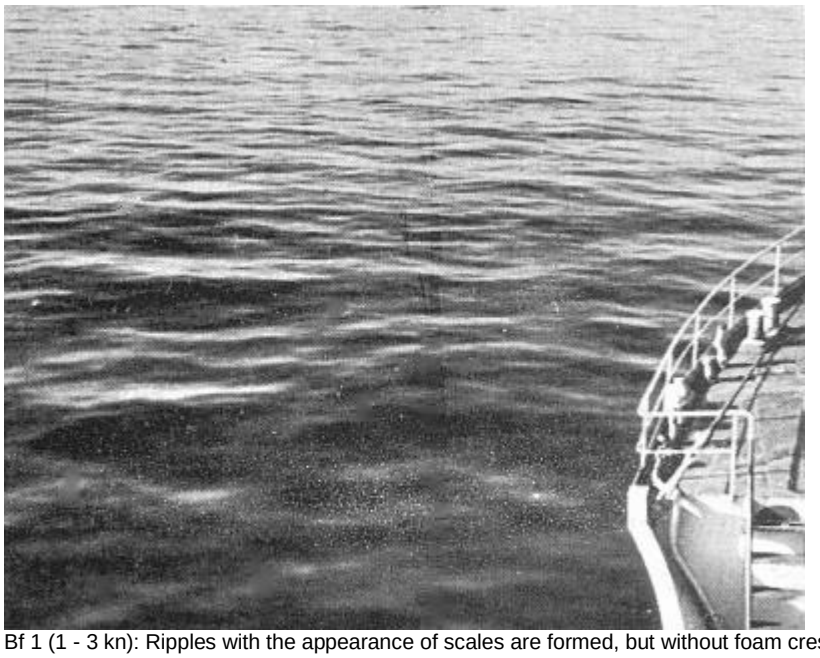
Bf 9 (41 - 47 kn): High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility

Bf 10 (48 - 55 kn): Very high waves with long overhanging crests; the resulting foam, in greater patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; the tumbling of the sea becomes heavy and shock-like; visibility affected

Bf 11 (56 - 63 kn): Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected

Beaufort scale KNMI

Bf 0 (< 1 kn): Sea like a mirror



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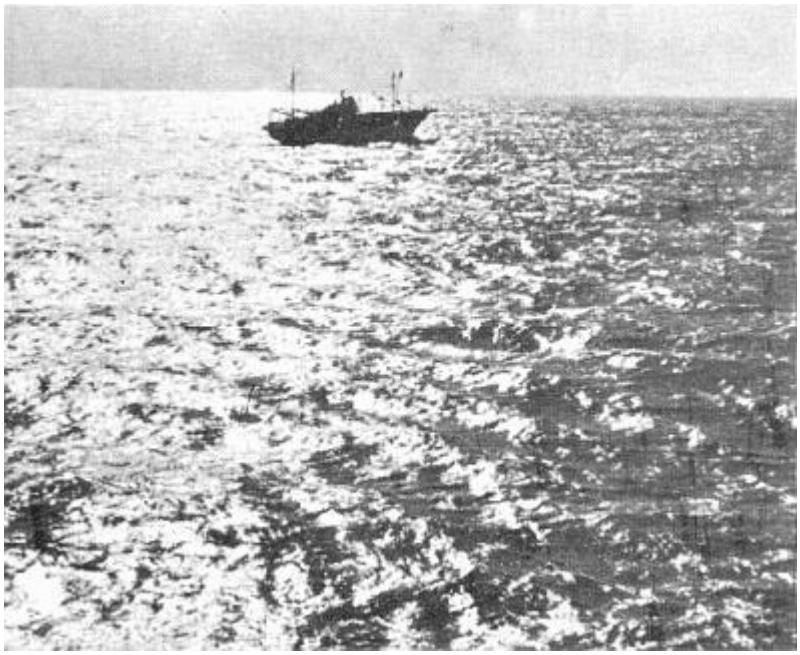
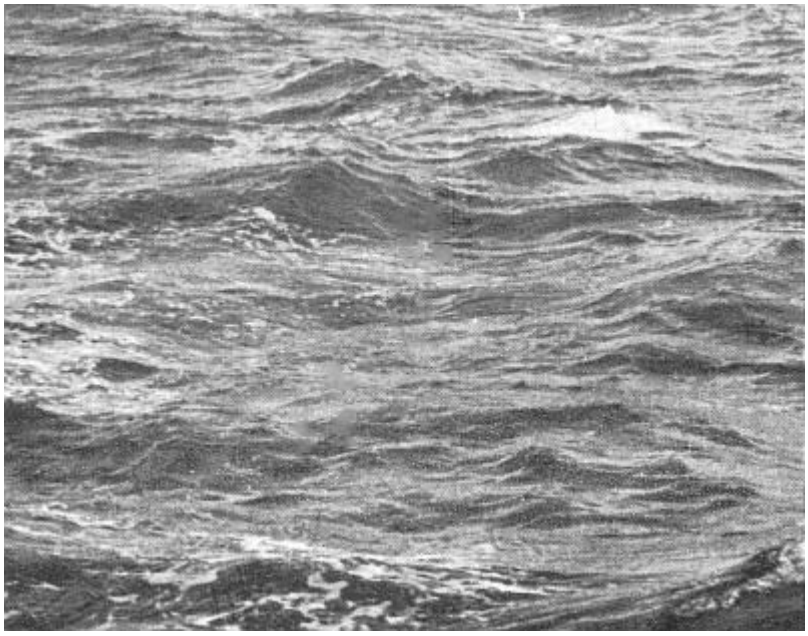
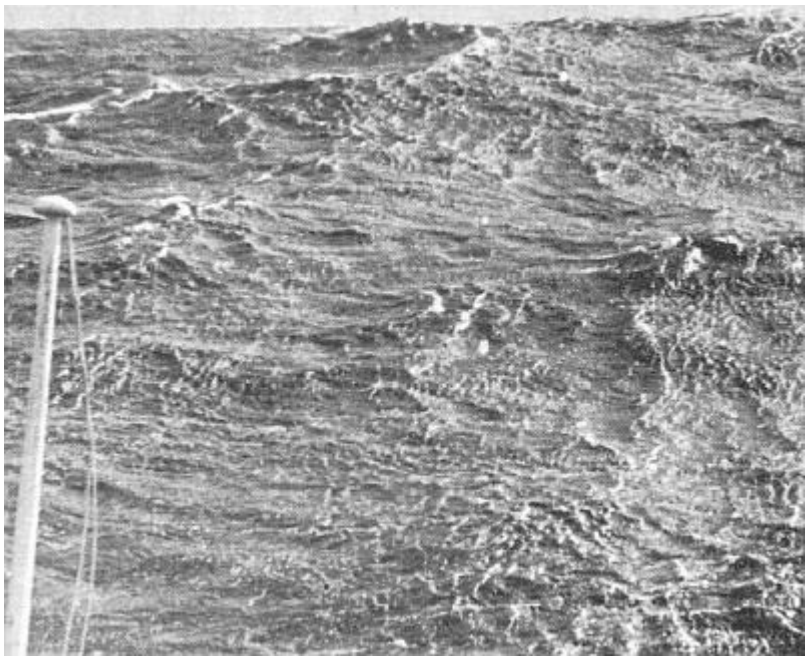


Bf 3 (7 - 10 kn): Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses

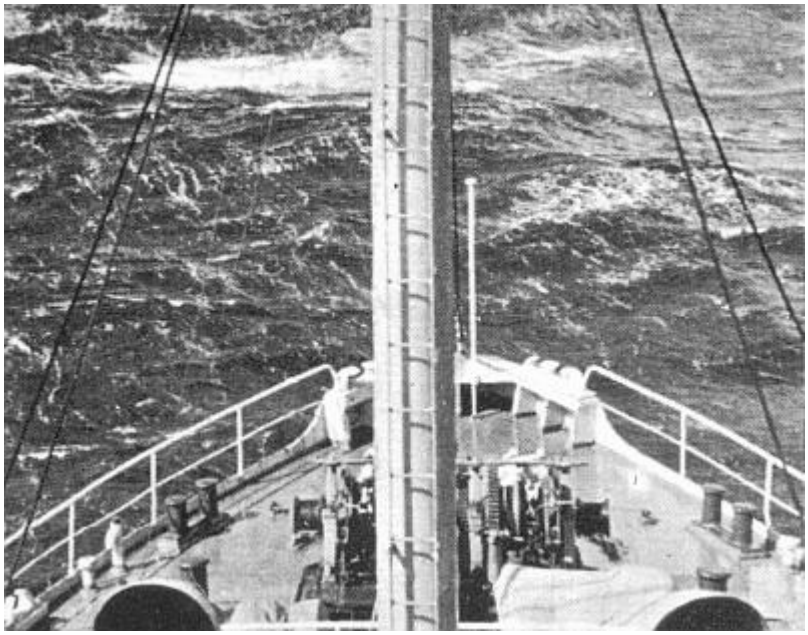


Bf 4 (11 - 16 kn): Small waves, becoming longer; fairly frequent white horses



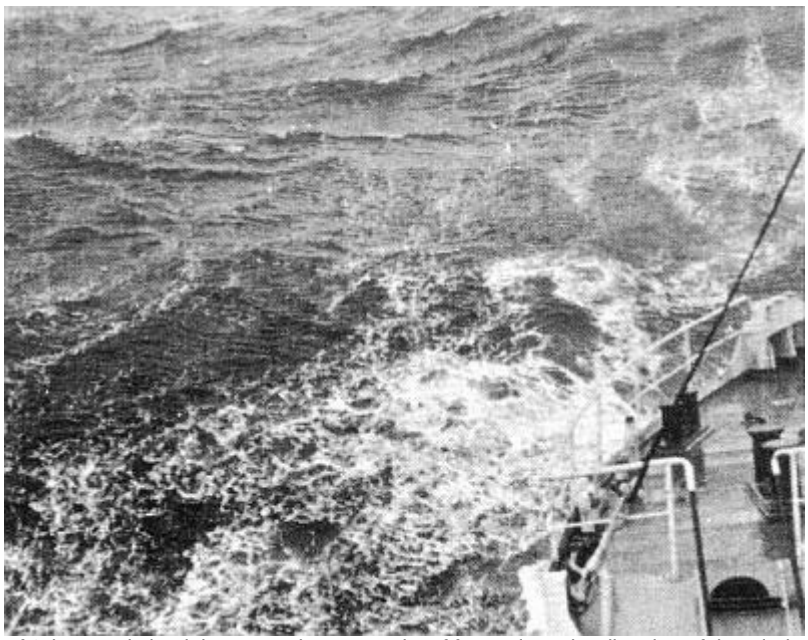
Bf 5 (17 - 21 kn): Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray)

Bf 6 (22 - 27 kn): Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray)

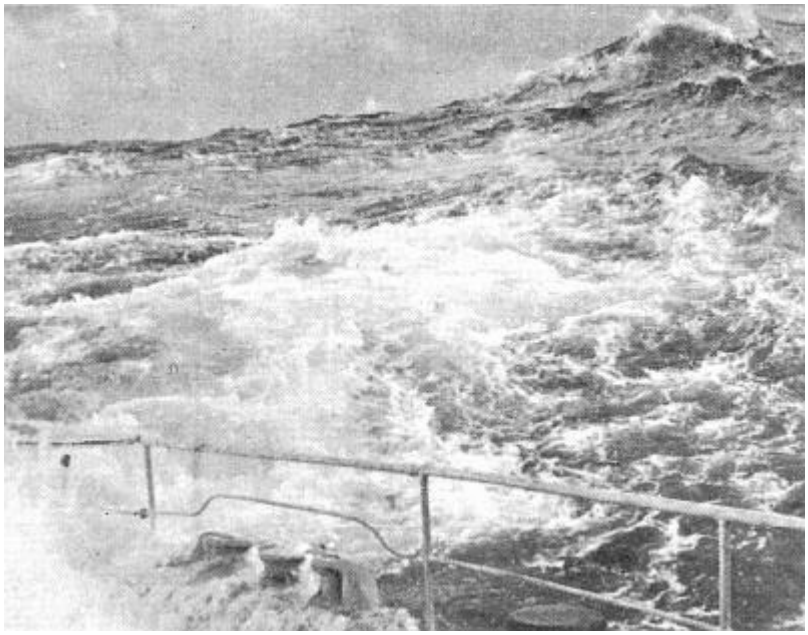


Bf 7 (28 - 33 kn): Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind

Bf 8 (34 - 40 kn): Moderately high waves of greater length; edges of crests begin to break into the spindrift; the foam is blown in well-marked streaks along the direction of the wind



Bf 9 (41 - 47 kn): High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility



Bf 10 (48 - 55 kn): Very high waves with long overhanging crests; the resulting foam, in greater patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; the tumbling of the sea becomes heavy and shock-like; visibility affected

Bf 11 (56 - 63 kn): Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected

Bf 12 (> 63 kn): The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected

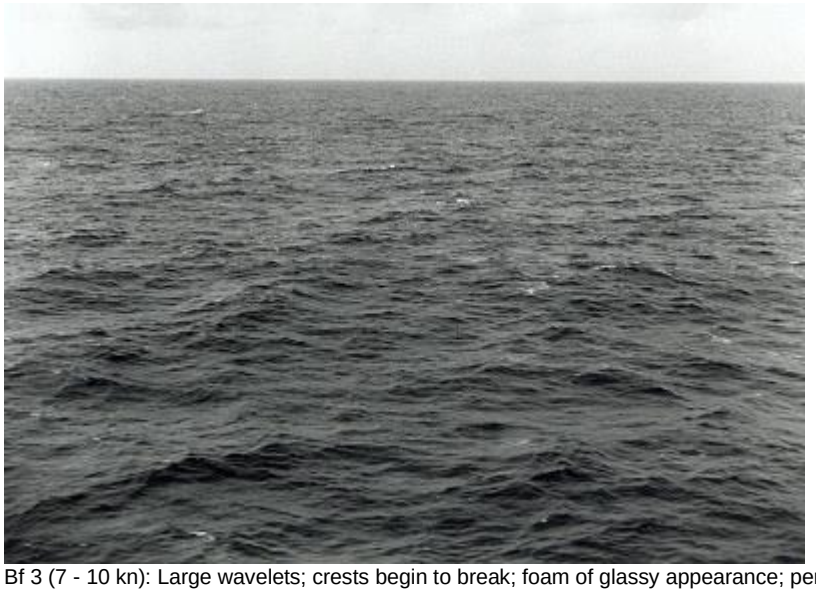
All photos KNMI

Beaufort scale the Met Office

Bf 0 (< 1 kn): Sea like a mirror

Bf 1 (1 - 3 kn): Ripples with the appearance of scales are formed, but without foam crests

Bf 2 (4 - 6 kn): Small wavelets, still short but more pronounced: crests have a glassy appearance and do not break



Bf 3 (7 - 10 kn): Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses

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Bf 12 (> 63 kn): The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected

Bf 0, Bf 1, Bf 2, Bf 5, Bf 6, Bf 7and Bf 8 photo by R.R. Baxter (Crown Copyright)
Bf 3 photo by R. Palmer
Bf 4 photo by P.J. Weaver
Bf 9 photo by O.R. Bates
Bf 10 photo by J. Hodkinson
Bf 11 and Bf 12 photo by Post Office (Crown Copyright)

Wind direction estimated

Visual estimates will normally be based upon the appearance of the surface of the sea. The wind direction is determined by observing the orientation of the crests of sea waves, i.e., wind- driven waves and not waves raised by the wind in a distant area, or the direction of streaks of foam which are markedly blown in the direction of the wind.

Wind speed estimated

Visual estimates will normally be based upon the appearance of the surface of the sea. The wind speed is obtained by reference to the Beaufort scale and the specifications for each number. The specifications of the Beaufort scale numbers refer to conditions in the open sea.

Note

- Factors which in general must be taken into account in estimating wind speeds are the lag between the wind increasing and the sea getting up, the smoothing or damping down of wind effects on the sea surface by heavy rain, and the effect of strong surface currents (for instance, tidal currents) on the appearance of the sea. Sea criteria become less reliable in shallow water or when close inshore, owing to the effect of tidal currents and the shelter provided by the land.

Apparent wind (off the bow)

definition: A wind vector with a speed referenced to the vessel and a direction referenced to the bow of the vessel

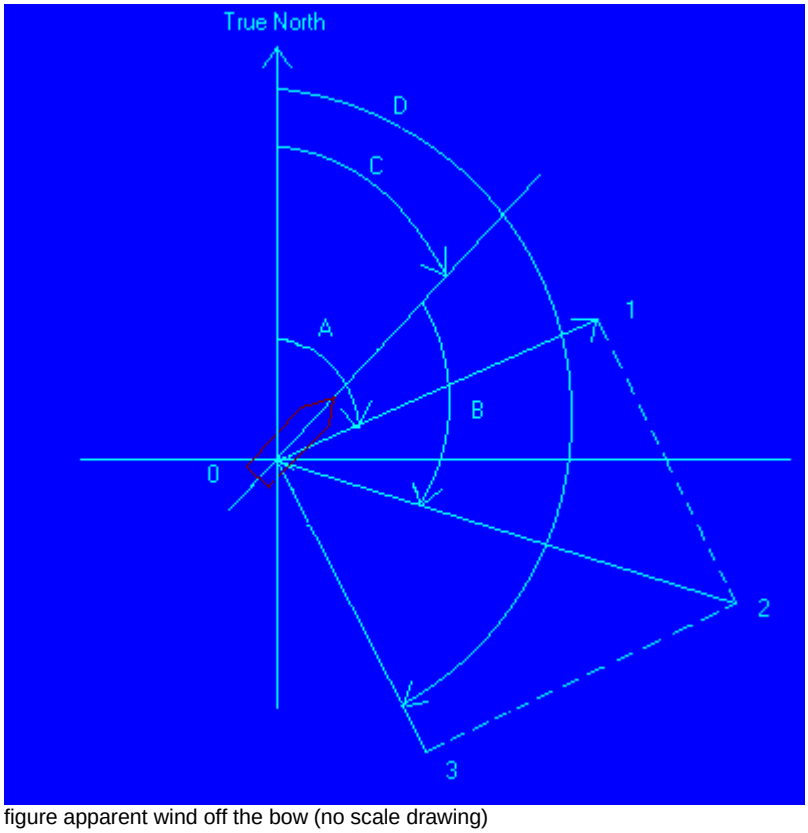


figure apparent wind off the bow (no scale drawing)

legend:
A = ships ground course
B = apparent wind direction off the bow (clockwise)
C = ships heading
D = true wind direction
0-1 = ships ground speed
2-0 = apparent wind speed
3-0 = true wind speed

Apparent wind (with respect to True North)

definition: A wind vector with a speed referenced to the vessel and a direction referenced to True North

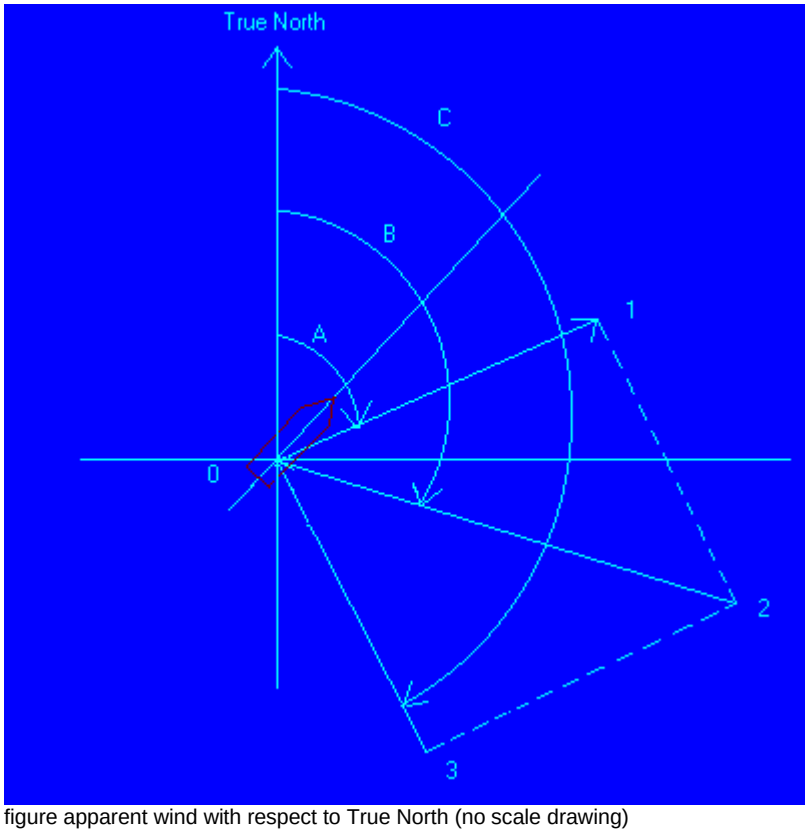


figure apparent wind with respect to True North (no scale drawing)

legend:
A = ships ground course
B = apparent wind direction with respect to true north
C = true wind direction
0-1 = ships ground speed
2-0 = apparent wind speed
3-0 = true wind speed

Wind direction measured

anemometer and wind vane (photo KNMI)

Ships fitted with cup anemometers, wind vanes or anemographs, should report the mean reading over a ten-minute period or, if the wind changes markedly in the ten-minute period, an average over the period after the change. When observations are taken from a moving ship, it is necessary to distinguish between the apparent wind (NO allowance made for ship's course and speed) and the true wind (with respect to True North direction; allowance made for ship's course and speed). For the meteorological observation, the true wind shall be reported. With this program the apparent wind will be converted to true wind automatically.

Note

- If the apparent wind direction is used as input: please insert the apparent measured wind direction as accurate as possible. The computed true wind will be more accurate (e.g., insert 346 instead of the rounded value 350).

Wind speed measured

Ships fitted with cup anemometers, wind vanes or anemographs, should report the mean reading over a ten-minute period or, if the wind changes markedly in the ten-minute period, an average over the period after the change. When observations are taken from a moving ship, it is necessary to distinguish between the apparent wind (NO allowance made for ship's course and speed) and the true wind (with respect to True North direction; allowance made for ship's course and speed). For the meteorological observation, the true wind shall be reported. With this program the apparent wind will be automatically converted to true wind. No wind height reduction must be applied for ships

Wind height reduction

For the meteorological observation (obs) no wind height reduction must be applied

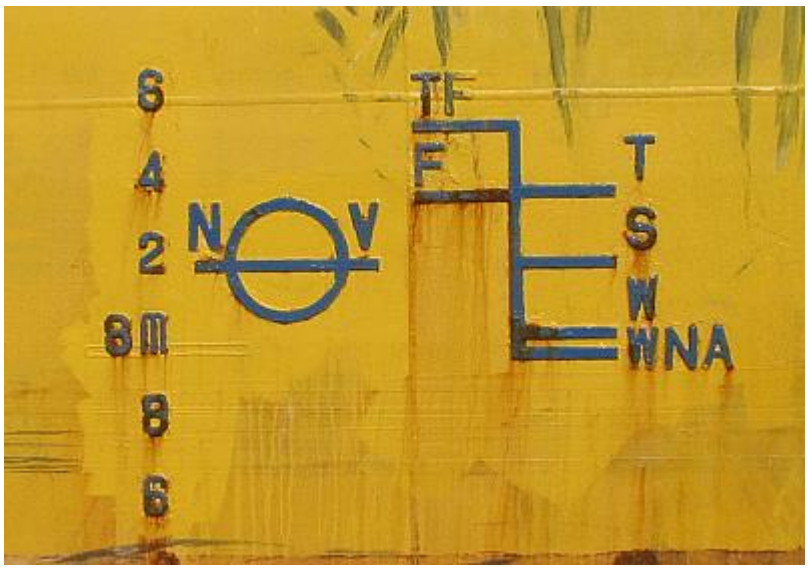
Max. height deck cargo above summer load line

Report to the nearest whole metre

deck cargo (photo KNMI)

Difference between summer load line and water line

Difference to the nearest whole meter between the summer load line and the sea level. Consider the difference positive when the summer load line is above the level of the sea and negative if below the water line



load lines (photo by PMO B. de Vries, KNMI)

Instruments

Anemometer This consists of cups rotatable about a vertical shaft or a propeller rotating about a horizontal shaft. When driven by the wind at a speed proportional to wind force, the rotating shaft drives an electrical generator whose output is itself proportional to the speed of rotation. A voltmeter may thus be calibrated as wind speed. Anemometers are not normally used aboard merchant ships because of the difficulty of finding a suitable site and also because of expense. The UK Ocean Weather Ship carries anemometers on the yardarms at a suitable height above the water (23m), which seems to be the site furthest from eddying effects. But even here estimates of wind force and direction from the appearance of the sea are regularly made as a check on the instruments. (See Figure 17).

Figure 17. Anemometer and wind vane

Hand anemometer
Whilst estimates of wind force and direction made on merchant ships by observations of sea state are to be considered the norm, a hand-held anemometer can be used for verification or in sheltered waters where the appearance of the sea may be modified by topographic features. The hand anemometer is held with its axis vertical, at arm's length, with the arm at right angles to the wind

direction to avoid disturbance of the airflow by the observer's body. At least two readings of mean wind speed need to be taken within the overall period of observation, each reading being taken over at least 15 seconds. The wind speed is shown by a graduated scale across which a pointer moves. Hand anemometers are calibrated in knots over a range of 0 to 60.

Digital hand anemometer
This is similar to the hand anemometer except that the speed sensing mechanism does not make use of switched contacts. After sampling for 15 seconds the instrument displays the average wind speed digitally for a further period of 10 seconds. The body and switch of the anemometer are waterproof and support legs fixed to the body protect the cups against damage when the instrument is laid down. The power is supplied by battery with an indication when battery voltage is low.

Wind vane

The wind direction may be directly observed by the position of the wind vane or remotely read at deck level by an electrical direction transmitter known as a Magslip for mains power or a Desynn in the case of a battery system operated through gear wheels and a countershaft. Both types may be joined to an anemometer unit so that the two instruments form a single transmitting head.

Non-instrumental Observations

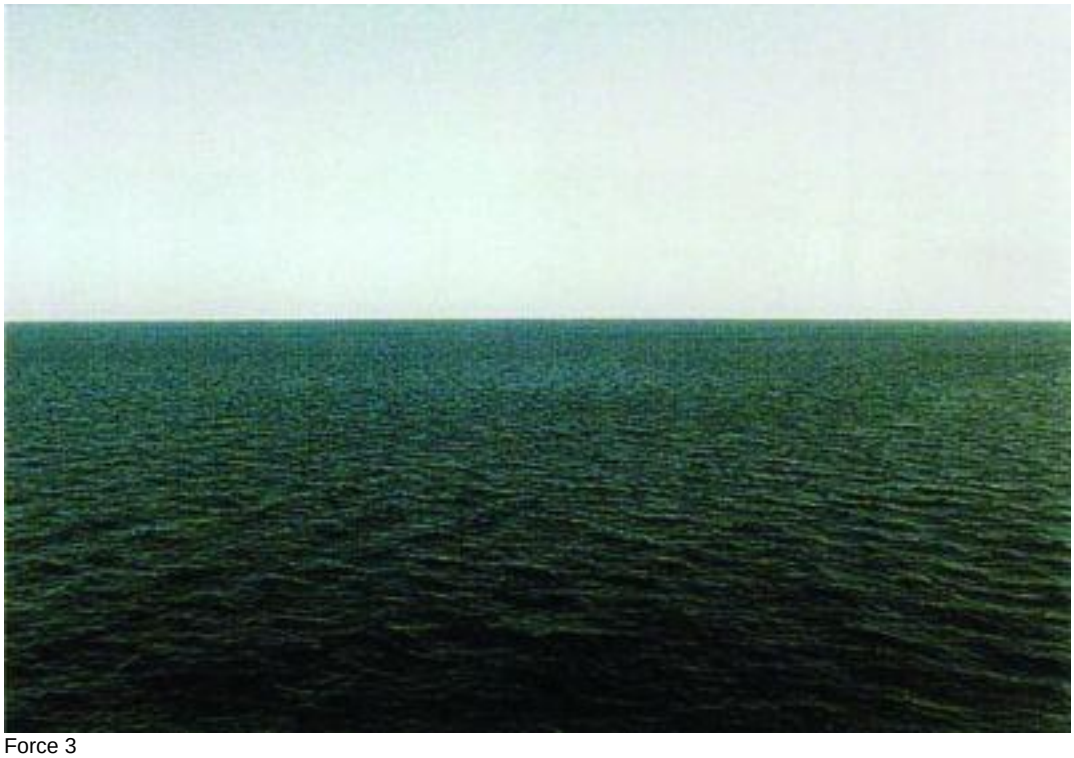
Wind force and direction

Wind force is expressed numerically on a scale from 0 to 12. This scale, which originally defined the wind force in terms of the canvas carried by a frigate, was devised by Captain, afterwards Admirals Sir Francis Beaufort in the year 1806 for use in vessels of the Royal Navy. Since Admiral Beaufort's time, however, so many changes had taken place in the build, rig, and tonnage of seagoing vessels that in 1874 Beaufort's scale was adapted to the full- rigged ship with double topsails of that period. With the passing of sail, this specification meant very little to those who had no experience in square-rigged ships, and the practice arose of judging wind force from the state of the sea surface. In 1939 the International Meteorological Organization, now the WMO, agreed to the use of a sea criterion by which the wind force was judged from the appearance of the sea surface. Photographs showing the appearance of the sea corresponding to each Beaufort force are given below.

Force 0

Force 1

Force 2



Force 3

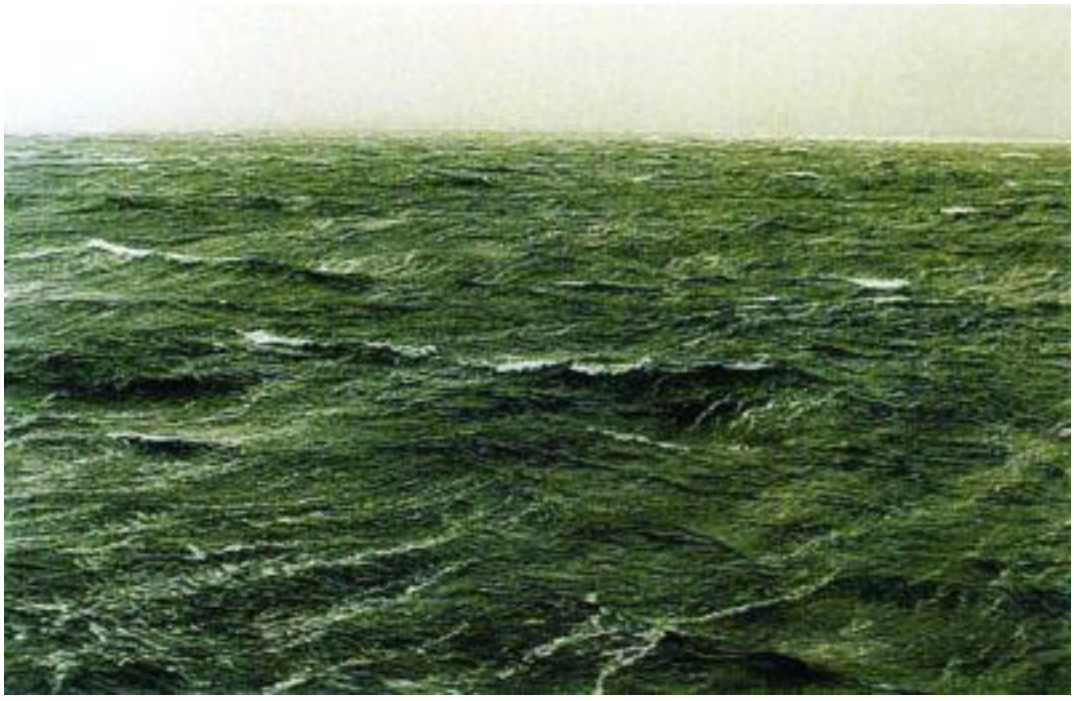
Force 4

Force 5

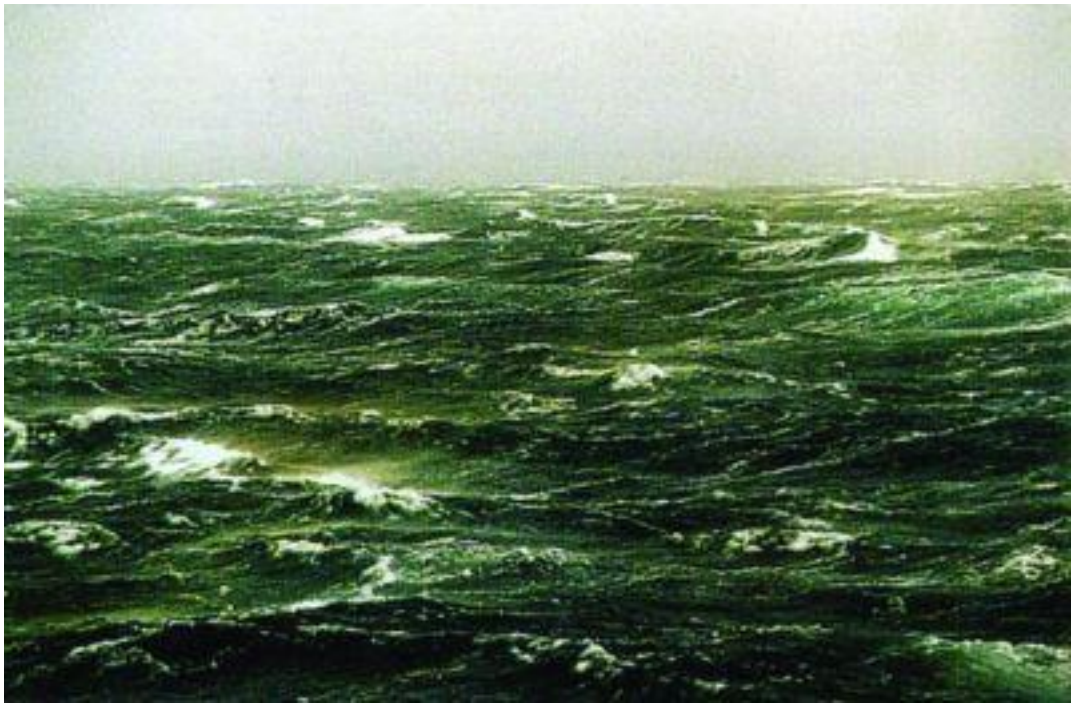
Force 6

Force 7

Force 8



Force 9



Force 10

Force 10

Force 10

Force 11

Force 11

Force 12


Force 12

In using this specification it is assumed that the observation is made in the open ocean and that the wind has been blowing long enough to raise the appropriate sea. The possibility of a lag between the wind getting up and the sea increasing must be considered. The appearance of the sea surface also depends on many other factors such as the fetch of the wind (i.e. distance from weather shore), the swell, the presence of tides, and whether or not precipitation is occurring. These effects should be allowed for before deciding the appropriate number on the scale. Experience is the only sure guide but the following remarks may be of some use:

(a) A discrepancy between wind and sea occurs frequently close inshore where winds of a local character are likely.

(b) An off-shore wind does not produce its appropriate sea close inshore but requires a certain fetch before its full effect is produced.

(c) Swell is the name given to waves, generally of considerable length, raised by winds at a considerable distance from the point of observation. Swell is not taken into account when estimating wind.

(d) Tides or strong currents affect the appearance of the sea surface, a wind against tide or current causing more 'lop' – a weather tide – and the wind in the same direction as a tide or current producing less disturbance of the sea surface – a lee tide.

(e) Precipitation, especially if heavy, produces a smoothing effect on the sea surface.

(f) There is evidence that the height of the sea disturbance caused by a wind of a particular force is affected by the difference between sea and air temperatures, the sea being the warmer medium. If this difference increases, there is an appreciable increase in the sea disturbance, and vice versa.

Beaufort force can be transformed approximately into wind speed by means of a table of equivalents

The International Code (used for making meteorological reports by radio) makes provision for the reporting of wind speed in knots (or metres per second). The observer may derive this from the table

of equivalents, taking the mid-point of the range corresponding with the observed Beaufort force; or, better still, he may interpolate according to his own judgement. For example, if the wind is estimated to be over Beaufort *5* but not quite Beaufort 6, it might be reported as having a mean speed of 21 knots.

Wind direction is logged as the true direction and is given to the nearest ten degrees. The exposed position that a ship's standard compass usually occupies gives a clear all-round view and from it the observer takes a compass bearing, noting the tops of the waves, the ripples, the spray and the faint lines that generally show along the wind. It is usually best to look to windward in judging wind direction, but in some lights the direction is more evident when looking to leeward.

Meteorologists as well as seamen use the term 'veering' to indicate a change of wind in a clockwise direction and the term 'backing' to denote a change in an anticlockwise direction. Estimation of wind force and direction can often be made in the same way at night but sometimes on very dark nights it is impossible to see the effect of the lighter winds on the sea surface. In such cases, the apparent or relative wind force and direction must be estimated by their effect, i.e. by the 'feel' upon the face or upon a moistened finger, or by the direction in which the smoke is blowing. Allowance must then be made for the ship's course and speed. In a fast ship considerable difference exists between the apparent and true wind directions. When the wind is astern and of the same velocity as the ship there is apparent calm on board the ship. In a calm, a ship steaming at 10 knots will have an apparent head wind of velocity 10 knots, but as soon as the wind blows from any direction out of the fore and aft line, the difference between the apparent and true directions will vary with each angle on the bow, and with each force of the wind. The true wind may be obtained from the apparent wind by use of the parallelogram of velocities, or Table 10 as explained below. In Figure 19 if, for example, the ship is travelling along the line AB with speed 15 knots and the wind appears to be coming from the direction DA with speed 29 knots (Beaufort scale 7), the true direction of the wind is along CA and its speed 18 knots.

This result is easily obtained graphically by drawing the figure, making BA proportional to 15 and DA proportional to 29, and then measuring DB which is equal to CA, where ABDC is a parallelogram. The angle CAD, which is the same as BDA, is measured with a protractor and gives the difference between the true and apparent directions of the wind. Table 10 enables the conversion from apparent to true wind to be made by inspection.

In fast vessels the task of estimating accurately the true wind force and direction is no easy one and special care is required; this applies particularly to occasions when the wind is very light, and on dark nights.

Anemometers have as yet found only limited use at sea, the chief problem being to achieve a suitable exposure. Estimation of wind force and direction from careful observation of the sea state is the method preferred. The ship disturbs the airflow in its vicinity with the result that the wind measured by the instrument is not representative of the true airflow over the open sea. If a portable cup-anemometer is used, the exposure may be varied at will and the best position chosen for any particular wind direction. The instrument measures 'apparent' wind speed. To determine the true value, the wind direction must first be estimated and then allowance made for the speed of the ship.

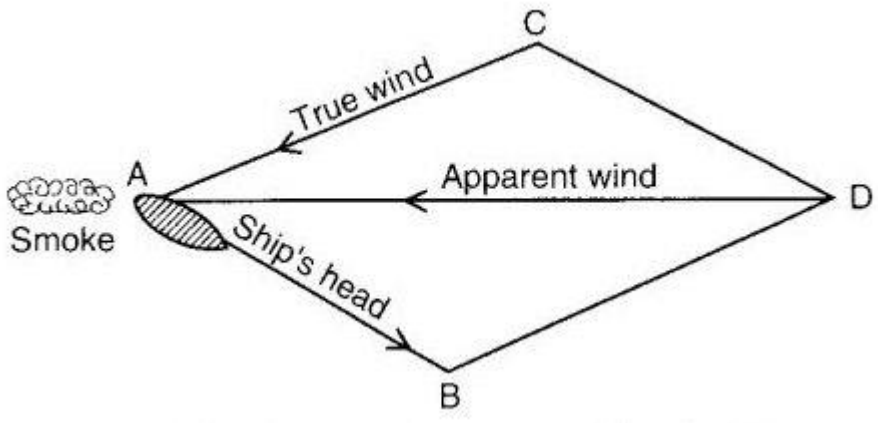


Figure 19. Wind, parallelogram of velocities,

Wind force and direction, taken alone, do not completely specify the character of the wind. It is well known that on occasions the wind is particularly gusty, as in showery weather. Less frequently, definite squalls may occur. The difference between a gust and a squall is essentially one of time-scale, a gust being momentary, whereas a squall may last several minutes. It is important when making the observations to note any unusual gustiness and the occurrence of squalls. When the latter occur it is of advantage if the time be noted together with any sudden change in wind direction. It is of interest to note that gusts have no appreciable effect in raising waves, whereas squalls may act for a sufficient length of time to raise a group of waves which tend to travel with the squall.